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FY91 ANNUAL REPORT OF POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION

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FY91 ANNUAL REPORT OF POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION

93FE0360 Tokyo DONEN NENPO in Japanese Sep 92 pp i-85

[Selected portions of the FY91 PNC Annual Report published in Sep 92]

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■ Addendum

Development of FBR

93FE0360A Tokyo DONEN NENPO in Japanese Sep 92 pp 1-7

[Text] **1. Development of Fast Breeder Reactor**

1.1 Operation of JOYO Experimental Fast Reactor

The JOYO experimental fast reactor, which first went critical in April 1977, was initially powered by breeder reactor cores having thermal outputs of 50 MWt and 75 MWt, but in August 1983, it switched to an irradiation reactor core having a rated thermal output of 100 MWt. Since then, we have conducted irradiation tests on fuel materials, tested plant characteristics, and developed an operation and maintenance control technology.

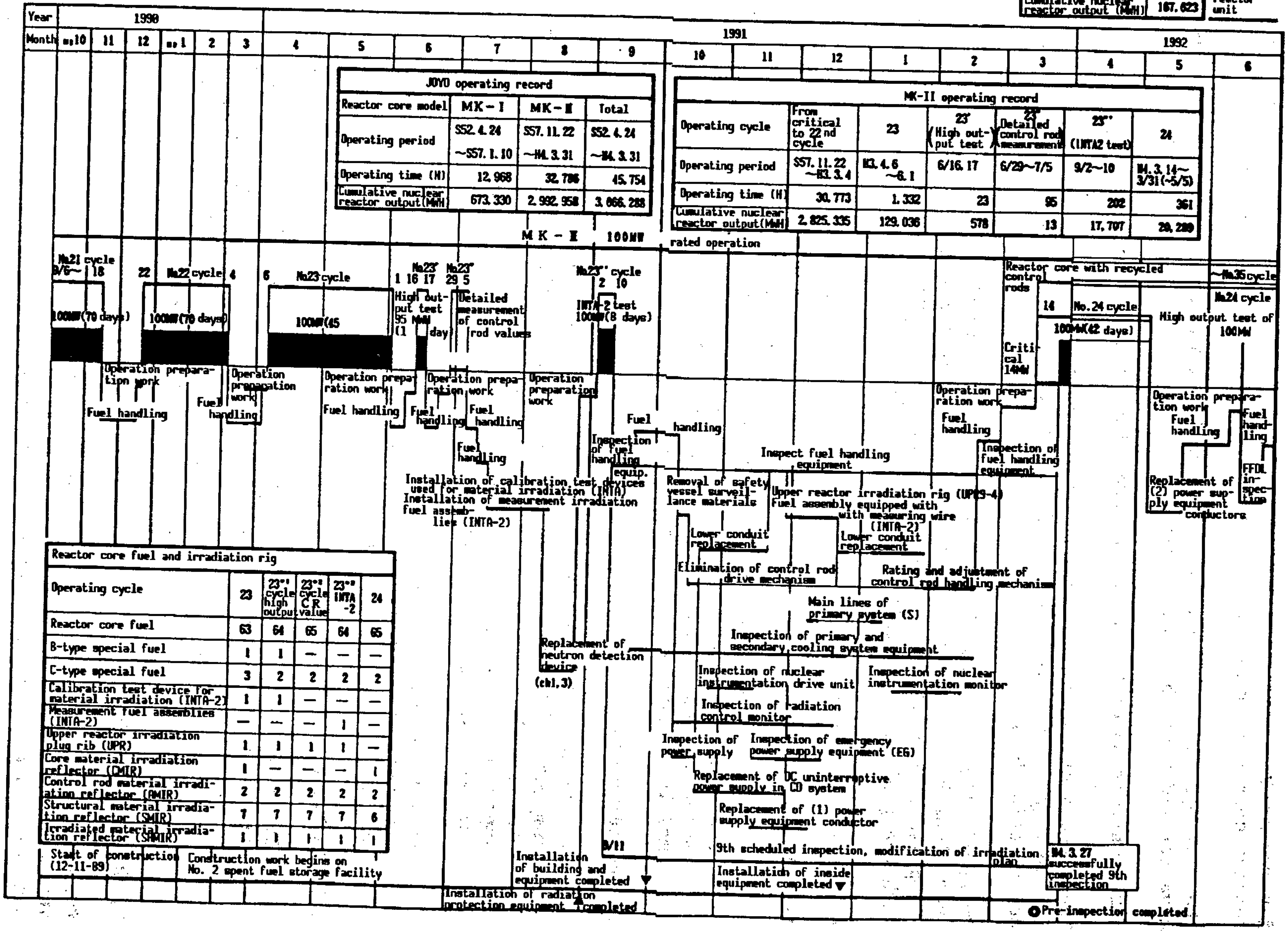
From 6 April to 31 May of this year, the JOYO reactor finished its 23rd operating cycle. From 16-17 June, it underwent a high output test (Operation Cycle No. 23'), and from 2-10 September, it underwent tests to measure specific control rod values (Operation Cycle No. 23'').

From 11 September, the JOYO reactor began its ninth scheduled inspection which lasted for seven months. On 27 March 1992, that inspection, which was given by the Science and Technology Agency, was declared a complete success. The total thermal output production of the JOYO reactor has been about 3,7 million MWh, or approximately 46,000 hours of operation. The operating record for 1991 is shown in Table 1.1.

In related irradiation tests, we completed a bundle behavior verification test of the JOYO reactor, and an irradiation test for high fuel burnup on the MONJU reactor which went into operation in February 1986. These were followed with an exchange of irradiation tests between France and Japan, an irradiation tests commissioned by a university, and other irradiation tests on reactor core materials and structural materials.

In matters requiring government authorization, the PNC received official authorization on 3 September 1991 to make installation changes (13th thereof) related to replacing control rods, authorization to build an additional waste treatment facility, and authorization to add more reactor core fuel assembly material (improved austenite stainless steel). In May 1992, the PNC will apply

April 1992 Table 1.1 Time Line for JOYO Experimental Fast Reactor (1991 operating record)



1991 operating method		
Operating time (H)	2,013	Experi-mental reactor unit
Cumulative nuclear reactor output (MWH)	167,623	

JOYO operating record			
Reactor core model	MK-I	MK-II	Total
Operating period	S52.4.24 ~S57.1.10	S57.11.22 ~H4.3.31	S52.4.24 ~H4.3.31
Operating time (H)	12,968	32,786	45,754
Cumulative nuclear reactor output (MWH)	673,330	2,992,958	3,666,288

MK-II operating record						
Operating cycle	From critical to 22nd cycle	23	23' (High out-put test)	23" (Detailed control rod measurement)	23''' (INTA2 test)	24
Operating period	S57.11.22 ~H3.3.4	H3.4.6 ~6.1	6/16.17	6/29~7/5	9/2~10	H4.3.14~ 3/31(~5/5)
Operating time (H)	30,773	1,332	23	95	202	361
Cumulative nuclear reactor output (MWH)	2,825,335	129,036	578	13	17,707	20,280

Reactor core fuel and irradiation rig					
Operating cycle	23	23'' cycle high output	23'' cycle C.R. value	23''' INTA-2	24
Reactor core fuel	63	64	65	64	65
B-type special fuel	1	1	—	—	—
C-type special fuel	3	2	2	2	2
Calibration test device for material irradiation (INTA-2)	1	1	—	—	—
Measurement fuel assemblies (INTA-2)	—	—	—	1	—
Upper reactor irradiation plug rib (UPR)	1	1	1	1	—
Core material irradiation reflector (CMIR)	1	—	—	—	1
Control rod material irradi-ation reflector (AMIR)	2	2	2	2	2
Structural material irradia-tion reflector (SMIR)	7	7	7	7	6
Irradiated material irradia-tion reflector (SMIR)	1	1	1	1	1

for permission to make installation changes (14th thereof) related to a reactor core test burnup (RCTB) and addition of nitride materials.

The development of a temperature-controlled irradiation device continues to move forward with the goal of beginning irradiation tests in 1993.

1.2 Construction of MONJU Fast Breeder Prototype Reactor

The preparatory work for construction of the MONJU fast breeder reactor began in January 1983. March 1992 will mark the 78th month since full-scale construction began.

By April 1991, all installation work had been completed, and by May, trial operations had begun. By the end of 1991, construction was 98% complete. At the present time, the MONJU reactor in undergoing comprehensive function tests with the goal of going critical by the spring of 1993.

1) Construction Work

(1) Civil Engineering Work

By the end of 1991, 99% of all civil engineering work had been completed. The work in 1991 included on-site road construction, security related work, and landscaping. In 1992, the main work will mainly involve on-site landscaping.

(2) Building Construction

By the end of 1991, 99% of all building construction work had been completed. This work included closing the nuclear reactor auxiliary building which had been temporarily opened. This is one of the most important building of the complex. Work was also completed on the turbine and diesel buildings.

As far as other buildings, construction work was completed on a new environmental management building, and work is now underway on a new solid waste storage facility.

(3) Electrical Work

By the end of 1991, 98% of all electrical work had been completed. The main electrical work in 1991 included reactor vessel leakage tests (prior to sodium fill), acceptance of 1,700 tons of sodium at a temporary sodium supply facility, and sequential filling of sodium while in temporary storage based on trial operation schedule.

2) Trial Operations

The trial operations of the MONJU consist of comprehensive function tests that are done after the equipment is installed and before the reactor is loaded with fuel, and performance tests that are done before the reactor reaches 100% output.

In 1991, the main comprehensive function tests consisted of a mock reactor core configuration test conducted in air, a control rod drive mechanism test, a test for filling the primary system with argon gas, a reactor vessel preheating test, and an in-sodium primary system test. Work was also done on ways to deal with thermal heat displacement in the secondary system which was discovered during the preheating test.

The main tests scheduled for next year include an in-sodium primary system test and a comprehensive test of the coolant systems.

3) Design and Manufacture

The main equipment and facilities of the MONJU reactor were mainly designed and built under the supervision of four companies—Toshiba, Hitachi, Fuji, and Mitsubishi.

The work in this area in 1991 included the manufacture of a new fuel transport cask, design of a neutron instrument handling machine, and fabrication of a standby control rod drive mechanism and reactor core fuel assembly.

4) Permits

These activities come under the Nuclear Reactor Law. In 1991, this work included applying for official authorization to make changes in design and construction methods, and to enact procedures related to security regulations.

5) Contracts

Contracts were prepared for the performance tests that are scheduled to start in 1993.

In October 1991, the contract with the Japan Atomic Power Company for on-site management was renewed.

1.3 Fast Breeder Reactor R&D

1) R&D on Reactor Physics and Design of Large Reactors

In the development of methods for analyzing reactor cores, we developed nuclear design analysis code groups, neutron transport calculation codes, evaluated the nuclear characteristics in advanced fuel reactor cores, made a comprehensive evaluation of the JUPITER critical experiment being implemented jointly by the United States and Japan, and designed a modified reactor constant in which a reactor constant adjustment technique was applied to analysis findings from the JUPITER experiment.

In research on shielding, we developed a shielding analysis code group for large reactors, conducted a large-scale shielding experiment with the United States, and did a follow-up analysis of that experiment.

In research on large-scale reactor design, we looked into designs where the objective was more durability but less cost and relatively smaller electrical

output (600,000 KWe). This research will be used to support development of an experimental reactor that could be put into practical operation with an estimated output ranging from 600,000 KWe to 1,500,000 KWe. Other research included studies on a small-to-medium-sized reactor and advanced fuel reactor from the view of fast reactor technology diversification and sophistication.

2) Machinery and System R&D

In the area of sodium cooling equipment development, we did an experiment to test creep strength in bellows materials under high temperatures.

In the development of an advanced reactor shutdown device for large reactors, we designed a conceptual system that will fit the needs of a large-scale plant.

In the development of control instruments, we did calibration tests on a flowmeter used for measuring flow distribution in the MONJU reactor. An analysis and evaluation of that data is now being done. Various flow rates were used in order to develop a calibration test for electromagnetic flowmeters with low flow volumes. In R&D on systems, we did a static characteristic test and flow stability test to ascertain the thermal conduction flow in secondary expurgation-type steam generators (double-pipe steam generator), and did various other tests on systems for detecting internal pipeline leakages in order to ascertain internal and external pipeline leakage characteristics.

The PNC developed an inspection device that can be used in the reactor vessel and primary system main pipelines when servicing the reactor. The work involved in developing the detection device included making a one-fifth scale model (comprehensive function test facility) of the reactor vessel and guard vessel, and using the scale model to test the systems and make improvements in the detection device based on those test results.

3) Fuel and Structural Material R&D

In order to move prototype fuel to high burnup reactor cores and develop high-performance fuels oriented toward practical reactors, we developed fast reactors fuels with an eye toward developing fuel analysis and design codes, fuel assemblies, clad pipeline material, irradiation tests, and post-irradiation tests.

In the development of fuel analysis and design codes, we developed an evaluation code for transition fuel behavior and failed fuel pin behavior, evaluated the corrosion behavior inside clad pipelines made from ferritic steel, collected basic irradiation data on advanced fuels (nitrides, metallic fuels, etc.), and did preparatory work for installation and irradiation.

Fuel assembly characteristics were tested under high burnup conditions.

The development of clad piping material included research on pipe manufacturing methods and development of high-strength ferritic and martensite stainless steel.

The irradiation tests conducted on the JOYO reactor included a test on transference of prototype fuel to the high burnup rate reactor core, and various tests oriented toward practical implementation. There were also fuel reliability tests at the EBR-II in the United States on transition operating periods (TOP) and failed fuel operation restart (RBCB). In a joint Japan-France exchange program involving the JOYO and PHOENIX reactors, we continued irradiation work on the JOYO reactor.

The post-irradiation testing facility at the Oarai Engineering Center is conducting post-irradiation tests on experimental fuels used in the prototype reactor and experimental reactor, and on fuels and materials irradiated by the PHOENIX reactor.

Construction and installation work is now in progress on a large-scale post-irradiation testing facility that will be used to test critical elements of the MONJU reactor core. Testing equipment and transport containers are also now being developed.

R&D on structural materials shows some progress in expanding and developing general-purpose non-linear structural analysis programs, and in developing more sophisticated non-linear structural analysis methods, ie. non-axial buckling, and configuration equations concerned with repeat plasticity. A more advanced method for evaluating creep fatigue is also being developed in order to try and standardize methods for making strength evaluations.

In the area of structural verification work, we conducted a heat transfer strength test on welded reactor vessel models for the purpose of obtaining weld creep strength data at the stress points where the bands are tightened and obtaining weld strength data on SUS316FR stainless steel.

For structural verification tests on antiseismic properties, we developed a scaled-down model to test a structural design that allows equipment to move up and down.

In-atmosphere and high chromium-molybdenum steel tests are now moving forward with broader material strength standards.

An experimental reactor irradiation rig and a JMTR irradiation rig are being used for irradiation tests on reactor structural materials.

The testing of sodium equipment materials included in-sodium clad pipeline tests for corrosion, creep, and tension.

4) Safety R&D

The tests on sodium transient heat flows in the reactor core unit included tests for heat transfer between fuel assemblies using a 19-pin bundle, and elucidating heat transfer characteristics during transient periods.

The tests for water flow within the reactor body included a basic core plenum water flow test that examined the conditions under which reverse flows are

generated, and the heat flow behavior in core channels when heat is lost through natural circulation.

A heat transition test was conducted under the hypothetical case of damage to major pipelines. This test was designed to increase the amount of data available concerning transition heat flows in fuel assemblies units.

Tests on parallel flow instability were conducted in order to elucidate the sodium boiling phenomenon in a multi-channel system where decay heat is emitted.

In developing safety analysis codes for heat flows, we used a stress algebraic expression to improve the turbulence analysis function by analyzing natural circulations in the general multi-dimensional heat flow analysis code (AQUA). We improved the inter-assembly single-phase subchannel analysis code (ASERE) was improved by a wire spacer model. We verified the code using results obtained from inter-assembly heat transfer tests. The analysis accuracy of the inter-assembly boiling analysis code (SABENA) was improved by using a high-degree differential analysis method.

In research on core stability, we conducted a comprehensive evaluation of test results on interactive fusion jet structural materials that were used in the high temperature mock testing device (MELT-II) for the purpose of evaluating retention performance inside the core vessel of molten core material under hypothetical core disintegration. We also initiated tests on the interaction of molten bodies and cooled materials, and on heat flow behavior in the core pool.

As far as in-reactor stability test being implemented as part of an international project, we continued work on the CABR I-II project to elucidate the critical phenomenon pertaining to transient behavior of fuel pins under hypothetical core disintegration, and try to improve the accuracy in how equipment is actually evaluated. The project also called for a test of high burnup fuel pins, and an analysis and evaluation of completed tests. As for in-reactor stability tests on the SCARABEE reactor, this work included a BE+3 test evaluation on a mock fuel assembly failure and development of an analytical model for the disintegration of the fuel pin bundle. It also included an analysis and evaluation of the PI-A test that was mockup of a pipe rupture that had spread to adjoining assemblies, and a PV-A test that was a mockup of molten bodies that had spread to adjoining assemblies.

In the development of safety analysis codes, we improved code groups and designed ways to analyze various accident sequences. This work involved developing various element models of the reactor disintegration process analysis code (SIMMER-III) and initiating research for verifying each of those.

In research on plant safety, we did mockup tests on cold states related to fission products (FP) released from fuel, and conducted FP foam in-sodium fusion tests for the purpose of evaluating the behavior of FP migration. The research also involved tests on a mixed aerosol made from sodium, iodine, and tellurium, and a report on the damping effect of aerosol concentration.

The tests on sodium combustion included a test to measure emissivity when aerosol has become stuck to the walls and to measure the damping factor of radiant heat in the flotation space, and thus improve the analysis code model of multi-dimensional combustion. In testing for sodium-water reaction in the steam generator, we did an analysis on rupture propagation in heat transfer lines in order to limit DBL, which is the scale for design standard events, and thus improve the analysis code model related to evaluating safety in the secondary elimination plant.

The probability safety assessments (PSA) on the MONJU prototype reactor were completed for internal factors, and work is now underway on Level 1 PSA for external factors such as fires and earthquakes. As for a consequential analysis of accidents, we did an analysis and evaluation of accident progression of various accident categories (ULOF, UTOP, ULOHS, and LOHRS events, etc.), quantified this information, and organized this into Level 2 PSA results.

In a joint project between the United States and Japan, we expanded the reliability data base on FBR machinery, and did an analysis and evaluation of data collection, organization, and acquisition.

In the work on the FBR safety test reactor, which has been going on since 1987, we did studies on in-reactor safety tests needed for practical implementation of the fast reactor, and also did studies on conceptual test facilities that would be needed to make this possible.

Development of Uranium Enrichment Technology

93FE0360B Tokyo DONEN NENPO in Japanese Sep 92 p 18

[Text] **4. Development of Uranium Enrichment Technology**

4.1 Uranium Enrichment Plant

1) Prototype Plant

The first uranium enrichment facility (DOP-1) and second uranium enrichment facility (DOP-2) have been in continuous operation since May 1989 and April 1988, respectively. Both facilities operated according to plan in 1991.

2) Practical Cascade Tests

In 1990, as a pilot plant scale test using a centrifuge with a body built from new materials, a group of electric power companies began conducting joint research in practical cascade tests. In 1991, the centrifuge and peripheral equipment that configure the cascade were built. Preparatory work on installing that equipment was also begun at the same time.

3) Pilot Plant Trials

At the end of 1989, the centrifuge was disassembled and inspected in order to evaluate durability with respect to the pilot plant having completed trial operations.

4.2 Development of Centrifuge Separating Methods

The work of fabricating the centrifuge body with new materials led to the development of a collector that proved useful in the practical cascade tests mentioned above. That work also ended the joint research being conducted by the electric power companies.

4.3 Development of Laser Enrichment Methods

Since 1988, the Power Reactor and Nuclear Fuel Development Corporation (PNC), with the help of The Institute of Physical and Chemical Research (RIKEN), has

been conducting engineering verification tests on uranium enrichment using a molecular laser method.

The device used in the engineering verification tests (engineering verification test device) is configured from a 100 Hz laser system and a uranium fluoride supply and recovery system. This is a scaled up version of the molecular laser method developed by RIKEN.

Uranium enrichment tests were conducted using the same test device that was installed last year.

Development of Plutonium Fuel

93FE0360C Tokyo DONEN NENPO in Japanese Sep 92 pp 19-20

[Text] **5.1 MOX Fuel Production**

In the development of fast breeder fuel, we continued production work on MONJU loading fuel.

In the development of advanced conversion reactor fuel, we completed production work on the 18th (18 units) fuel replacement for the JOYO reactor, and started work on the 19th (29 units) fuel replacement. By the end of March 1992, the cumulative total of plutonium fuel produced had reached a total of 113 tons MOX for both DCA fuel and irradiation fuel.

1) Fast Reactor Plutonium Fuel

Work continued on production of MONJU loading fuel.

2) Advanced Conversion Reactor Plutonium Fuel

Here, we completed production work on the 18th (18 units) fuel replacement for MONJU reactor and started work on the 19th (29 units) fuel replacement.

3) Inspection of MOX Fuel Component Materials

Acceptance inspections continued on clad pipelines, fuel element frames, and assembly frames for the JOYO MK-II and FUGEN fuel replacement.

Acceptance inspections were completed on rubber pipelines and clad pipelines in the 6th fuel replacement for the JOYO MK-II reactor.

Acceptance inspections and official inspections were completed on clad pipelines, fuel element frames, and assembly frames for the 20th (27 units) and 19th (29 units) MOX fuel replacement of the FUGEN reactor.

Acceptance inspections and official inspections continued on clad pipelines, fuel element frames, and assembly frames for the first fuel loading and fuel replacement of the MONJU reactor.

5.2 Construction of MOX Fuel Production Facility

By the end of December 1989, we had completed construction work, electrical work, air-conditioning work, and utility work on the plutonium fuel production facility ATR, and at the same time, completed preparatory work on ordering equipment.

5.3 Plutonium Fuel Utilization Technology

(1) In order to verify irradiation behavior of MOX fuel in high burnup rate regions, we conducted one irradiation test (IFA-514) with a Halden [phonetic] reactor, and another irradiation test (IFA-565) using fuel elements taken from part of the fuel after completing a post-irradiation test for a high burnup rate.

(2) In January 1990, in an irradiation project involving a small number of BWR fuel units at the 1st reactor facility of the Japan Atomic Power Company, we completed irradiation work and started post-irradiation tests on plutonium —thermal fuel (2 units).

(3) In the overseas PWR plutonium-thermal irradiation project, we continued conducting irradiation and post-irradiation tests on a Halden [phonetic] reactor.

Preparations are also being made for irradiation of transported fuel assemblies for the purpose of conducting irradiation tests on the BR-2 reactor.

(4) In the overseas BWR plutonium-thermal irradiation project, we continued irradiation work on a Dotword [phonetic] reactor.

5.4 Plutonium Conversion Technology

(1) In the development of plutonium hybrid conversion technology, we continued work on a demonstration scale plutonium conversion technology development facility that will be used for uranium-plutonium hybrid conversion by a microthermal direct denitration method (MH method).

In 1991, the reprocessing plant produced approximately 513 kg of plutonium nitrate solution and mixed 513 kg of plutonium.

(2) In the development of hybrid conversion technology, we successfully completed engineering tests given at a denitration test facility using recovered uranium. The technology was later improved in the fuel production equipment laboratory.

Meanwhile, in order to demonstrate the scope of the hybrid technology, a test device was installed at the PNC Ningyotoge location. In 1990, practical demonstration tests were begun using uranium.

(3) Wet recovery and refining equipment was introduced. This equipment was used for refining and recovering fuel scraps during the fuel production process. The equipment is now operated under controlled supervision. The denitration process also underwent trial operations and is now being tested with uranium.

We also installed new solution treatment test equipment which is now undergoing trial operations.

5.5 Development of New-Type Fuels

While the main focus of energy has been directed toward the development of MOX fuel for fast breeder reactors, an emphasis is also being placed on nitrides and metallic fuels that exhibit higher heat conductivity and greater metallic density than MOX fuel. These fuels are basic leading-edge technologies that reach beyond the range of FBR development, so research and technical feasibility studies are being done on these fuels from every aspect of the cycle (reactor characteristics, fuel manufacturing, reprocessing, costs of waste disposal, etc.).

In research on nitride fuel, we installed fuel production test equipment, and made a study of N enrichment methods that inhibit C generation.

The research work on metallic fuels included metallic conversion tests with UF6 and UO2, and a basic test of the molten-salt electrolytic method.

Creative, Innovative R&D

93FE0360D Tokyp DONEN NENPO in Japanese Sep 92 pp 33-34—FOR OFFICIAL USE ONLY

[Text] **8. Creative and Innovative R&D**

Creative and innovative frontier research is being promoted in order to take practical advantage of the technology base that has been built up from previous R&D. This can be divided into two major categories. The first is R&D where new concepts are developed, and the second is basic R&D which shares the same subject matter.

8.1 Research for Creating New Concepts

1) Research on Nuclear Species Separation and Disintegration

As part of long-term future-based R&D, the PNC is promoting research on disintegration of long-life nuclides, i.e. transuranium (TRU), that are contained in high-level radioactive wastes. We are also doing research aimed at reducing nuclide levels by fast reactor or accelerator.

In research on disintegration of nuclides, we conducted evaluation tests in which CMPO was used as an extractant for isolating TRU from the residue of uranium and plutonium extraction, and from high-level waste after reprocessing. The results from basic tests so far confirm that TRU can be extracted relatively easily with a CMPO solvent.

In order to recycle TRU, however, a reverse extraction must be done from the CMPO side. This alone is not enough, so one of the major subjects in the future will be to come up with a new solvent other than CMPO.

By adding about 5% TRU to MOX fuel based on core analysis results, a way was found to reduce TRU without having a negative affect on the core characteristic in eliminating TRU by fast reactor. Preparatory work is now being done on JOYO irradiation tests involving TRU nuclides in order to verify the nuclear data required for design research. Research is also moving forward on fabrication of fuel containing TRU.

We continued work on a theoretical analysis for the elimination of FP (strontium, cesium, etc.) by an accelerator. We are also developing a high-

current electron beam accelerator for the purpose of developing a high-output accelerator technology which is needed for elimination work. That is why a facility is being built to develop accelerator and element technologies, i.e. acceleration tubes, klystrons.

We are also conducting basic process research on developing ways to recover usable metals from the insoluble residues during reprocessing, and on ways of conducting high-temperature separation.

2) Research on New Fast Reactors

Conceptual studies are now being done on new fast reactors that can greatly improve energy efficiency, create more diverse uses for nuclear power energy, and improve safety.

Conceptual systems are being studied for the purpose of developing a miniature transportable reactor, which can be used on isolated islands or deserts, and a hybrid reactor, which is a combined nuclear fusion and nuclear fission reactor.

8.2 Development of Basic Nuclear Power Technologies

1) Research on Artificial Intelligence

A study of plant concepts as well as research on element technologies is being done with the ultimate aim of creating a completely automated nuclear power plant that requires no human decision-making in operational control and plant maintenance. Artificial intelligence would be employed in the operation and maintenance of the plant.

With the immediate aim of having automated normal operations and semi-automated operations during emergency periods, research is moving forward on element technologies, i.e. knowledge bases, malfunction diagnosis, and state prediction, and also on an operation control system that integrates these into one system.

2) Research on New Materials and Superconductivity

In order to greatly improve the economics of next-generation nuclear power plants, clad pipelines made of gradient function materials are being developed with the goal of improving performance of fast reactor fuels. Research is also moving forward on ceramics and super heat-resistant alloy structures with the goal of improving thermal efficiency of the reactor vessel. Research is moving forward on ultrafine particulate and the fine clusters found in ceramics which are expected to improve the sintering characteristic of MOX pellets.

In the area of superconductivity, a magnetic separation method is being developed which employs superconducting magnets.

3) Research on Laser Applications

In order to make the reprocessing operation simpler yet more sophisticated, basic tests are being done for the purpose of adjusting the atomic valences of elements such as plutonium and neptunium. Basic process research is moving forward on laser applications with the goal of separating carbon-14, which is found in the offgas generated in the reprocessing operation. Research is also looking into the separation of long half-life elements such as palladium-107, which are contained in usable metals recovered from insoluble residues. Progress is also being made in developing a free-electron laser that will improve the output and efficiency of laser applications needed for the aforementioned research.

Safety Control, Research

93FE0360E Tokyo DONEN NENPO in Japanese Sep 92 pp 37-60

[Text] **10. Safety Control and Research**

10.1 Safety Control

1) Head Office

The safety control activities of the head office of the PNC for 1991 were basically a continuation of last year's policy of providing guidance and support with respect to maintaining safe operations in each workplace, and of promoting and overseeing safety activities implemented by safety control departments in each facility.

In implementing safety control work in 1991, the following measures were adopted as the basic safety control policies for 1991. The head office then worked to enact these measures after sending notifications to each workplace.

- Step up safety activities with regard to prediction and prevention
- Develop safety activities based on experience
- Actively promote policies that reduce radiation exposure

The monthly meetings of the Central Safety Committee discussed important issues pertaining to facility safety.

The specific activities that ensued out of these committee meetings included a general safety inspection of each facility between October to December for verifying implementation of basic safety control policies. The committee also set into motion a series of studies on how to ensure safety and reduce radiation exposure at each workplace. This included receiving comprehensive quarterly exposure control reports.

The safety related events held during the year included a major conference on safety held during National Safety Week in July which was aimed at trying to increase safety awareness. Other events were a national fire-prevention drill

in September, and various training exercises having to do with communication, management personnel, and materials needed in emergency situations.

The PNC head office was also involved with managing an IAEA/RCA training program in October, and putting together a meeting of IAEA/RCA visiting specialists in December, and IAEA/RCA government specialists in March.

2) PNC Ningyotoge Facility

The safety control activities of the PNC Ningyotoge Facility were conducted according to the safety control plan for 1991. It was designed to implement various policies that would not only insure safety of employees, but would insure safety in and around the facilities using fissionable materials. Working with a specific goal of zero human injuries, the facility focused its efforts on KY activities based on the "cool-hot" movement, and tried to promote QA activities in terms of nuclear facility safety.

As a result of those efforts, it recorded a record 2,406 continuous days without an accident stretching back to 30 August 1985.

(1) General Safety Control

The PNC Ningyotoge Facility safety plan included a monthly safety activities program and safety inspection tours. One day each month was designated as Safety Day, and on that day various activities were held including safety patrols, safety forums, safety education classes on the use of safety materials, and safety related events held during Mine Safety Week (July). These activities helped raise employee awareness concerning safety and security and educated people on how to deal with problems having to do with safety.

1. Committee activities

The Security Committee, the Safety and Hygiene Committee, and the Safety Committee met monthly to discuss and study important safety-related issues. The Security Committee and the Safety and Hygiene Committee helped organize inspection tours of each workplace. Various liaison committees such as the Quality Assurance Committee, the KY Promotion Committee, and the Safety Inspection Committee met regularly to work on their respective activities.

2. Establishing and/or revising regulations

The PNC Ningyotoge Facility completely revised the process facility security regulations, established operating rules, and made modifications in various regulations concerned with a name change for the facility. New regulations related to the security of Ningyotoge facilities and mine safety were approved in October.

3. Implementation of educational programs

These activities were conducted in accordance with the safety plan for the year and included giving proper safety training to new employees working in radiation related jobs by having them attend various educational lectures held at a nuclear fuel cycle engineering training lab. It also sought to improve worker quality by actively getting interested parties to attend outside lectures and take qualification tests.

(2) Radiation Monitoring

1. Individual exposure control

Dose equivalent readings for external exposure were taken quarterly from employees working in radiation-related areas. Results showed no unusual problems from external exposure. There were no unusual findings for internal exposure, either.

In Table 10.1, we show the dose equivalent results for exposure at the PNC Ningyotoge Facility for 1991.

2. Facility radiation monitoring

The uranium enrichment pilot plant, the uranium enrichment prototype plant, the smelting conversion facility, and the developmental testing building (installation of microwave denitration testing device and high-performance centrifuge) were monitored on a routine and non-routine basis. No radiation problems were found that violate safety regulations.

Radiation monitoring equipment and HF monitors were also routinely calibrated and inspected.

3. Environmental monitoring

The peripheral environment and discharge of waste water were regularly monitored in accordance with the environmental monitoring plan of the PNC Ningyotoge Facility. There were no problems in view of the target values established by environmental safety agreements, or in view of the basic values established by security regulations.

Report detailing these results were submitted to Okayama and Tottori prefectures as called for in agreements with each prefecture.

Atmospheric conditions such as wind speed, atmospheric temperature, and rainfall were also monitored from an observation platform located inside the uranium enrichment prototype plant.

Table 10.1 1991 Exposure Control (Ningyotoge Facilities)

Effective dose equivalent (mSv)		Less than 5 (persons)	5~15 (persons)	15~25 (persons)	25~50 (persons)	More than 50 (persons)	Total (persons)	Total dose equivalent (p·mSv)	Average dose equivalent (mSv)
Smelting facility	Employees	2	0	0	0	0	2	0	0.0
	Other employees	0	0	0	0	0	0	0	0.0
	Total	2	0	0	0	0	2	0	0.0
Facilities handling fissionable material covered under Article 16.2 of government ordnance	Employees	82	0	0	0	0	82	3.8	0.0
	Other employees	317	0	0	0	0	317	5.2	0.0
	Total	399	0	0	0	0	399	9.0	0.0
Facility handling fissionable material not covered under Article 16.2 of government ordnance	Employees	20	0	0	0	0	20	2.1	0.1
	Other employees	37	0	0	0	0	37	0.3	0.0
	Total	57	0	0	0	0	57	2.4	0.0
Processing facility	Employees	43	0	0	0	0	43	0.3	0.0
	Other employees	130	0	0	0	0	130	4.8	0.0
	Total	173	0	0	0	0	173	5.1	0.0

(Period: 1 April 1991 to 31 March 1992)

3) PNC Chubu Facility

Safety control at the PNC Chubu Facility was implemented in accordance with a safety control implementation plan and a business plan submitted at the beginning of the year. These activities included implementing safety measures for excavation work being done at the No. 2 mineshaft, teaching about general accident prevention, and checking for radiation in the nuclear source material mines.

(1) General Safety Control

1. Safety control system

This work included researching ways to measure and evaluate loose areas that result from mineshaft excavation, and preserving maintenance galleries or naturally similar phenomenon for the purpose of understanding the mechanics of stratum hydraulics and hydrology. In

September, excavation work was completed on the No. 2 mineshaft being drilled for underground scientific research.

The security management activities related to these work projects included putting into place a safety control system for shaft excavation contract work, enacting educational programs for new mine workers, prequalified mine workers, and designated mine workers, and implementing key safety activities related to the "Safety Issue of the Month" designated at the start of the year.

2. Security committee

Members of the Security Committee met two times per month to conduct inspection tours of each workplace and provide on-site instruction related to safety and security. A committee met monthly to look for ways of preventing accidents based on the discrepancies found during these inspection tours.

3. Safety education and instruction

a. Promoting emergency forecasting techniques

A TMB was held at the start of work in each department with the goal of trying to head off accidents before they occur.

b. As for educational activities, the facility held classes on safety for new mine workers, designated mine workers, and pre-qualified workers, and held open discussions on safety in each department. It also tried to improve worker quality and help them obtain special qualifications in specialized areas by having them attend lectures given by outside groups such as the Chubu Kinki Mine Safety Group.

c. As for promotional activities, bulletin boards were set up for promoting an accident-free workplace. In addition to the bulletin boards, there were also safety information boxes, green-cross calendars, and posters. Books on safety were also distributed monthly to each department for the purpose of raising awareness about safety and security.

d. Safety control for contracted workers

As for safety control for contracted workers who work involved in facility construction or equipment installation, the PNC Chubu Facility issued reports on safety implementation plans and safety related problems to those with overall responsibility for safety in those companies.

4. Security Events

a. To raise employee awareness concerning safety, the following events were held before and during National Mine Safety Week.

1–30 June— Prior to National Mine Safety Week: forums on safety, in-house inspections of each workplace, a safety slogan contest, and safety proposals

1–7 July Events during National Mining Safety Week: safety prayer services, forums on safety for front line employees, safety inspection tours, safety slogan awards ceremony, lectures on safety

b. **General safety inspections**

On 28–29 November, it conducted a general safety inspections of the test mine and the No. 2 mineshaft.

c. **Fire prevention training**

The events during Fire Prevention Week in the fall included a full-employee fire drill that was conducted with the help of the local fire department in Toki City. It included a training in communication, evacuation, firefighting, and rescue.

d. **Yama(no)kami (mountain-god) ceremony**

A "mountain–god" ceremony was held at the Tono mine with the aim of offering prayers for safety and raising awareness concerning safety.

5. Safety Inspections

To evaluate safety in the Tono mine, the Chubu Kinki Mine Safety Group conducted comprehensive safety inspections, detailed safety inspections, and other types of inspections, but found no significant problems.

(2) Radiation Monitoring

Measurements were taken on the concentration of radioactive materials inside mines, on the spatial cumulative dose in surrounding areas to the mines, on radon strength, and on exposure control for personnel working in radiation-related jobs. All results were found to be within legally specified limits.

In Table 10.2, we show the dose equivalent results for radiation exposure for the Chubu facilities in 1991.

(3) Preventing Mine Pollution

The water quality of underground wastewater, and streams and rivers around Tono mine, were also monitored. No unusual readings were reported.

3) PNC Tokai Facility

The safety control activities of the PNC Tokai facility have been turned into various safety control projects that are related in some way to safety regulations and basic safety control policies.

Table 10.2 1991 Exposure Control (PNC Chubu Facility)

Item	Employees	Other employees	Total
Effective dose equivalent (mSv)	51	62	113
Less than 5 (persons)	0	0	0
5~15 (persons)	0	0	0
15~25 (persons)	0	0	0
25~50 (persons)	0	0	0
More than 50 (persons)	51	62	113
Total dose equivalent (p·mSv)	7.9	4.3	12.3
Average dose equivalent (mSv)	0.2	0.1	0.1

The Safety and Hygiene Committee, the Safety Expert Committee, and the Safety Supervisors Committee met regularly to devise ways to raise employee awareness concerning safety and insure safety in the workplace.

(1) General Safety Control

The Safety and Hygiene Committee, Safety Expert Committee (includes expert subcommittees), and Safety Supervisors Committee held regular and non-regular meetings for the purpose of promoting safety throughout the entire facility. The Security Committee also held monthly meetings with personnel from the reprocessing plant and the plutonium fuel plant. It also met with other divisions as necessary. To raise employee awareness concerning safety, various safety related events were held in the period leading up to National Safety Week (1-30 June), and during National Safety Week itself (1-7 July).

A comprehensive safety inspections was held on 23-24 October.

The safety inspections in workplace included a safety patrol by the incoming and outgoing Safety and Hygiene Committee on 2 July and a monthly patrol by the Safety Supervisors Committee.

As far as official on-site inspections, Ibaragi Prefecture conducted a safety inspection of the high pressure gas manufacturing facility on 1 August as called for in the High Pressure Gas Control Law. It also conducted an inspection of the refrigerated high pressure gas facility on 11-12 December. On 21-22 November, the Science and Technology Agency conducted an inspection to see if safety regulations were being complied with at facilities using fissionable materials. On 27 September, the Mito Labor Standards Inspection Office also conducted an on-site inspection.

In the area of regulatory changes, the PNC Tokai Facility petitioned for approval to make changes in regulations related to security of facilities using fissionable materials. This request had to do with the director of the plutonium fuel production facility construction laboratory becoming a member of the Security Control Organization.

In regulatory activities related to the reprocessing facility, the facility received approval on April 8 for a review of a revision of the fissionable materials transport law, and was granted approval on 7 July to make changes in how control areas are set up inside the No. 3 uranium storage center.

Authorization was also granted on 4 October to make changes in how control areas are to be set up inside the incineration facility, and to add carbon-14 to the main nuclides involved in offgas emissions.

On 11 October, authorization was granted to make changes in a Nuclear Safety Commission decision related to environmental radiation monitoring plans. The facility also applied for permission to make changes involving the transfer of operational responsibilities of the incineration facility from the Environmental Facilities Division to the Reprocessing Plant.

In regulatory work for preventing radiation injuries, it made changes in the establishment of control zones inside the No. 2 Plutonium Fuel Development Lab, and sent notifications to that effect to the STA Mito Nuclear Power Plant.

(2) Radiation Monitoring

The following items describe the radiation monitoring activities at each of the facility.

1. As a result of radiation monitoring conducted at the Plutonium Fuel Plant and Plutonium Fuel Facility with regard to the manufacture of JOYO replacement fuel, MONJU loading fuel, and developmental fuel, two employees were found on 28 May to have been subjected to internal radiation exposure as a result of a slight contamination accident in the No. 3 Plutonium Fuel Development Laboratory. No other instances were found in which security regulations standards were violated. The No. 1 Plutonium Fuel Development Lab was also monitored for radiation in work related to disassembly and removal of the glove box.

2. The Nuclear Fuel Technology Development Division, the Reprocessing Technology Division, and the Environmental Facility were monitored for radiation. These places are involved with developmental tests on uranium enrichment, and development of analytical methods related to the nuclear fuel cycle, and in the treatment of plutonium wastes. The Safety Control Facility was also monitored for radiation in regards to its activities. With the exception of the incident described below, however, no instances were found where safety regulatory standards have been violated.

The high-level radioactive material research facility (CPF) was monitored for radiation. This facility is involved with developing reprocessing methods for fast reactor spent fuels and with test research on glass solidification of high-level radioactive waste. Results show a contamination incident took place on 9 January 1992 at the Analysis Laboratory involving two employees who were treated for internal radiation exposure. A control zone was set up and the area was restored to normal by Type-1 radiation work.

Other than that incident, there were no other cases where safety regulatory standards were violated.

3. Those workers working in radiation related jobs who have to wear breathing protection equipment were given tests on the use of half-face masks and full-face masks. After the tests, the workers were given proper instruction on how the equipment is supposed to be worn. All 1,683 workers tested in 1991 passed the test.

4. The stationary-type monitors and radiation measuring equipment used in the reprocessing and plutonium fuel facilities were serviced and maintained to keep them in perfect running condition at all times. In 1991, there were 6,209 scheduled inspections, including comprehensive inspections and calibrations, on stationary-type monitoring equipment, and 9,598 inspections on radiation measuring equipment. There were 1,515 repairs made to stationary-type monitors and radiation measuring equipment, and a total of 209 acceptance inspections made on stationary-type monitors and radiation measuring equipment at the time of purchase.

   As part of an exchange program sponsored by the Science and Technology Agency in the area of nuclear energy, the PNC Tokai Facility provided training to two technical engineers participating in the program from Vietnam and Bangladesh on inspection methods and radiation measuring equipment. In October, it also helped sponsor an IAEA/RCA training program. In February, it helped train the people responsible for managing JICA radiation safety.

5. The reprocessing facility, environmental facility, and the facility used for developing plutonium conversion methods and krypton recovery methods were monitored for radiation. Exhaust gases were also checked as well as the methods used to load and unload spent fuel.

   There were no findings where regulatory safety standards had been violated.

   The reprocessing facility successfully completed its seventh regular inspection. The 1st uranium storage center and incineration facility also passed an official inspection given prior to the start of commercial operation.

   A research study was made on the replacement of stationary-type monitors and introduction of a new radiation monitoring system at the No. 3 Low-Level Radioactive Waste Processing Facility.

(3) Safety Education

The PNC Tokai Facility helped promote safety education by sending instructors to teach various courses at the Nuclear Fuel Cycle Engineering Training Laboratory.

It also worked with those in charge of safety at high pressure gas manufacturing facilities and those in charge of handling dangerous materials. These people were allowed to take part in special lectures and training programs inside and outside the company in order to gain special qualifications in those areas.

On 4 June and 11 December, the PNC Tokai Facility conducted a criticality accident drill at the 1st, 2nd, and 3rd plutonium fuel development laboratories. The same drill was conducted at the reprocessing plant on 16 October, at the CPF on 11 November, and at the plutonium conversion development facility on 29 November. On 13 March, a general fire drill was conducted under the hypothetical situation of a fire in the fuel assembly storage warehouse inside the 1st plutonium fuel development laboratory.

(4) Individual Exposure Control

The PNC Tokai facility measured effective dose equivalent and dose equivalent in the skin, hands, and crystal lens of the eyes on a quarterly basis.

Table 10.3 shows the effective dose equivalent in 1991 for those workers working in radiation-related jobs at the PNC Tokai Facility. The highest individual reading was 46.6 mSv/year. This was below the acceptable dose equivalent limit set by law. The group dose equivalent was 1,342.3 persons•mSv.

The regular internal exposure control work included bioassays on 382 employees working in radiation-related jobs handling uranium and plutonium, lung monitors to take readings on 284 employees working in radiation-related jobs where plutonium is handled, and whole body counters to take readings on 6,469 people either working in relation-related jobs or allowed temporary access to the amber areas inside the reprocessing facility and CPF Facility.

Four workers who had been involved in a contamination incident at the 3rd plutonium fuel development lab on 5 March 1991 and at the high-level radioactive material research facility (CPF) on 9 January 1992 were also given special monitoring for internal exposure. The results indicated that the tissue (bone surface) dose equivalent for the two employees working in the latter location had exceeded the allowable limit of 500 mSv/year set by law.

As far as registration and management systems, various types of requests were made to have workers working in radiation-related jobs be registered and deregistered at a central registration center.

As part of an exchange program on nuclear research sponsored by the Science and Technology Agency, the PNC Tokai Facility offered special training on

Table 10.3 1991 Exposure Control (PNC Control Facility)

Effective dose equivalent (mSv)		Less than 5 (persons)	5~15 (persons)	15~25 (persons)	25~50 (persons)	More than 50 (persons)	Total (persons)	Total dose equivalent (p·mSv)	Average dose equivalent (mSv)	Maximum dose equivalent (mSv)
Reprocessing facility	Employees	615	0	0	0	0	615	153.7	0.3	4.5
	Other employees	1,553	5	0	0	0	1,558	312.6	0.2	6.9
	Total	2,168	5	0	0	0	2,173	466.3	0.2	--
Facilities handling fissionable material covered under Article 16.2 of government ordnance	Employees	338	9	0	0	0	347	152.4	0.4	10.4
	Other employees	1,369	54	2	2	0	1,427	723.6	0.5	46.6
	Total	1,707	63	2	2	0	1,774	876.0	0.5	--
Facility handling fissionable material not covered under Article 16.2 of government ordnance	Employees	31	0	0	0	0	31	0	0	0
	Other employees	148	0	0	0	0	148	0	0	0
	Total	179	0	0	0	0	179	0	0	--
Total	Employees	984	9	0	0	0	993	306.1	0.3	10.4
	Other employees	3,070	59	2	2	0	3,133	1036.2	0.3	46.6
	Total	4,054	68	2	2	0	4,126	1342.3	0.3	--

(Period: 1 April 1991 to 31 March 1992)

dosage assessment to one Thai and one Sri Lankan researcher. In October, it held an IEAE/RCA training course, and in February, held lectures and provided special training for JICA (Japan International Cooperation Agency) personnel supervising radiation safety.

(5) Environmental Monitoring

The PNC Tokai Facility continued to routinely monitor land and ocean conditions, and the emission of exhaust gases and wastewater, as called for in an environmental monitoring plan that was based on reprocessing facility safety regulations.

At the request of Ibaragi Prefecture, it also continued to conduct monthly inspections on the environmental impact of low-level radioactive waste being discharged into the ocean from the reprocessing facility.

The monitoring plan was revised in October 1991 due to replacement of underwater discharge lines.

In addition to the regularly scheduled work described above, it also conducted the following special activities related to research on the storage and transport of iodine-129 which is a supplemental survey category being managed by the Central Evaluation Subcommittee on Environmental Radiation Monitoring.

It continued doing water level surveys using soil samples taken from the surrounding environment. In terms of main exposure routes, it surveyed parameters related to the transport of iodine.

In addition, Japan Fuel Services, Ltd., also commissioned it to do a radioactivity analysis as part of a survey on environmental radioactivity.

It also provided training for two engineers from Japan Fuel Services and four engineers from Toden Environmental Engineering.

As part of a technical cooperation program with developing countries, the PNC Tokai Facility gave special training to one researcher from the Philippines and two researchers from the Indonesia on monitoring environmental radiation. It also provided special training for personnel from RCA and JICA who are responsible for radiation safety control.

4) Oarai Engineering Center

The Oarai Engineering Center developed a safety and hygiene management plan that was based on the basic safety and hygiene policies for 1991 that were formulated at the beginning of the year. The plan also took into account the events schedule for safety and hygiene and the events schedule for the center's joint educational activities. It then implemented specific safety control policies based on that plan.

The JOYO experimental fast reactor underwent its ninth scheduled inspection followed by a 100 MW rated operation. There were no radiation related problems encountered in either operation. There were also no problems found in any of the other facilities.

(1) General Safety Control

To promote general safety within the center, the Safety and Hygiene Committee met monthly to discuss items related to safety and hygiene management planning. Also, the Nuclear Reactor Safety Review Committee met every month to discuss and study issues related to requests to make installation modifications in the nuclear reactor facility.

The center also sought to raise employee awareness concerning safety by holding various events during the period prior to Safety Week, during Safety Week, Electricity Safety Week, and at the KY Conference.

The safety inspection work at the center in 1991 included inspections mandated by safety regulations, and two patrols (2) on preventing and responding to equipment operational failures that were conducted during the period leading up to Safety Week in June. The first patrol consisted of experts and the other featured a group of division heads. The center also conducted a safety patrol during Safety Week composed of members of the Safety and Hygiene Committee who inspected all of the facilities within the center.

A general safety inspection was given on 21–22 November. The results of the inspection gave the center passing grades for implementing safety activities, assuring safety at construction sites, and keeping the entire facility in good working order.

As far as official on-site inspections, the Science and Technology Agency conducted an inspection to see if safety regulations were being complied with at the Nuclear Reactor Facility and at the facilities where fissionable materials are used, and also made an on-site inspection of radiation related facilities. Ibaragi Prefecture, on the other hand, conducted a safety inspection of the high pressure gas manufacturing facility.

It also revised some nuclear reactor facility safety regulations related to construction of the 2nd JOYO spent fuel storage facility.

Operating from a plan formed at the beginning of the year, the center offered some classes on general safety, hazardous substance security, electrical safety, and other radiation related areas.

(2) Monitoring Radiation

The center monitored radiation at the nuclear reactor facility, at facilities using fissionable materials, and at facilities using radioactive isotopes. It found no unusual problems with respect to radiation control. It conducted routine in-house inspections of the stationary-type radiation control monitors installed in the nuclear reactor facility and in the fuel material testing facilities. It also inspected and repaired survey meters at the same time.

1. Nuclear reactor facility

After successfully completing its 23rd operating cycle, the JOYO reactor underwent a ninth scheduled inspection from 11 September 1991 to 27 March 1992. During that time, it was monitored for radiation related to the nuclear reactor operations, scheduled inspection work, and modification work.

The center monitored radiation inside the DO2 critical experiment lab related to measurement work on nuclear characteristics of demonstration reactor fuels.

2. **Facilities using fissionable materials**

The center conducted irradiation tests on various fissionable materials, i.e. JOYO MK-II fuel, at the irradiation fuel assembly testing facility, the irradiation fuel testing facility, and the irradiation material testing facility. It also monitored for radiation as it pertains to routine inspection work on cell boxes.

It also monitored for radiation at the solid waste preprocessing facility as it pertains to preprocessing work on large solid TRU waste containers, and at the sodium analysis lab as it pertains to analysis work on primary sodium and cover gas in the JOYO reactor. In addition to the regularly scheduled work described above, it also provided training in radiation control to one Thai researcher who was accepted at the center as part of a technical cooperation program with developing countries.

(3) Individual Exposure Control

1. **External exposure**

External exposure dosages were measured quarterly using TLD badges. Table 10.4 shows the 1991 Exposure Control for the Oarai Engineering Center. The yearly total dose equivalent was 466.5 mSv per person, and the maximum individual dose equivalent was 9.4 mSv per year. All employees were below the acceptable dose equivalent limit set by law.

2. The center took whole body counter readings and evaluated internal exposure on employees working in radiation-related jobs at each nuclear facility. It found no unusual conditions.

In addition to the routine work described above, the center also provided training in exposure control to one Malaysian researcher accepted at the center as part of a technical cooperation program with developing countries.

(4) Environmental Monitoring

The center measured dosage rates and concentration of radioactive materials in areas surrounding the center as called for by nuclear reactor facility safety regulations and the environmental radiation monitoring plan of Ibaragi Prefecture. It found no unusual problems. It also measured the concentration of pollutants in general wastewater as called for in a safety management contract with the Japan Atomic Energy Council and the Oarai district. It found no problems in these areas, either. The center continued to monitor meteorological conditions, i.e. wind direction, wind speed, as called for by nuclear reactor facility safety regulations.

Table 10.4 1991 Exposure Control (Oarai Engineering Center)

Effective dose equivalent (mSv)		Less than 5 (persons)	5~15 (persons)	15~25 (persons)	25~50 (persons)	More than 50 (persons)	Total (persons)	Total dose equivalent (p·mSv)	Average dose equivalent (mSv)
Facilities handling fissionable material covered under Article 16.2 of government ordnance (e.g. Irradiation Fuel Assembly Lab)	Employees	119	0	0	0	0	119	12.9	0.1
	Other employees	266	0	0	0	0	266	33.3	0.1
	Total	385	0	0	0	0	385	46.2	0.1
Facility handling fissionable material not covered under Article 16.2 of government ordnance	Employees	22	0	0	0	0	22	0.0	0.0
	Other employees	46	0	0	0	0	46	0.0	0.0
	Total	68	0	0	0	0	68	0.0	0.0
Nuclear reactor facility	Employees	165	1	0	0	0	166	47.3	0.3
	Other employees	429	21	0	0	0	450	373.0	0.8
	Total	594	22	0	0	0	616	420.3	0.7
Total	Employees	306	1	0	0	0	307	60.2	0.2
	Other employees	741	21	0	0	0	763	406.3	0.5
	Total	1,047	22	0	0	0	1,069	466.5	0.4

(Period: 1 April 1991 to 31 March 1992)

The center held quarterly meetings to discuss the dosage rate measurement findings with a subcommittee in charge of environmental radiation monitoring from the Oarai district, and also with a committee in charge of environmental radiation monitoring from the Tokai region in Ibaragi Prefecture.

6) FUGEN Advanced Conversion Reactor Power Plant

The safety management activities at the FUGEN Power Plant were promoted in accordance with a basic safety management policies formulated at the start of the year.

The plant completed its ninth scheduled inspection without any hitches. It included a start-up of the nuclear reactor on 29 April 1991 and a full-load inspection on 23 May.

The safety management activities for the year included toolbox meetings that were held at each workplace on "improving prediction and prevention safety activities" and "developing safety activities based on experience". Because of those meetings, and because of efforts to prevent accidents from occurring due to carelessness, inattentiveness, and negligence, the plant racked up its second consecutive year without an accident. From January 1982 until 31 March 1991, it went 4.4 million consecutive work hours without an accident involving power plant employees. That figure was 12.9 million work hours when the ATR Safety Research Institute and cooperating companies were included. That is a new record and is equivalent to 3,715 accident-free days.

Acting in accordance with basic management policies, the plant conducted classes on exposure control for the purpose of creating greater awareness about reducing exposure.

(1) General Safety Control

The Safety and Hygiene Committee met monthly to discuss and study issues related to safety and hygiene. A safety and hygiene patrol of the entire plant was conducted once a month to investigate work conditions and work environments. When it came to areas not up to standard, the patrol offered advice to help make improvements in those areas.

(2) Hygiene Management

The hygiene management activities included meetings of the Safety and Hygiene Committee on industrial medicine, general health diagnosis, specialized health diagnosis, and improving worker health.

(3) Vendor Safety Control

The ATR Safety Council, which is made of parties affiliated with the FUGEN Power Station, took an active role in organizing regular meetings, executive meetings, KY promotion liaison meetings, and joint director patrols. This was done as part of the safety activities plan for 1991.

As for safety activities related to scheduled inspections, the plant conducted KY activities based on the "cool-hot" experience, while working with plant personnel and personnel from cooperating companies.

(4) Monitoring Radiation

1. **Monitoring radiation at the facility**

   As for monitoring activities within control zones, the plant sought to insure safety by having the Safety Management Department meet beforehand with the department or party supervising the work and review radiation work. After that, the department gave advice and assistance on radiation protection and made an in-person inspection to make sure the work was being performed according to the stated plan.

the work was being performed according to the stated plan.

In 1991, there were 418 cases of work being done within control zones (includes 150 cases where work required special permission).

2. Individual exposure control

The plant monitored the dose equivalent of workers working in radiation-related jobs in accordance with security regulations and provisions pursuant thereto. In 1991, the plant employed 1,231 people including a staff of 200 people. Table 10.5 shows the dose equivalent distribution of employees working at the plant. The plant evaluated internal exposure by taking readings with a whole body counter. There were no problems reported regarding exposure levels.

Table 10.5 1991 Exposure Control (FUGEN Power Plant)

Item	Employees	Other employees	Total
Effective dose equivalent (mSv)	198	995	1,193
Less than 5 (persons)	2	36	38
5~15 (persons)	0	0	0
15~25 (persons)	0	0	0
25~50 (persons)	0	0	0
More than 50 (persons)	200	1,031	1,231
Total dose equivalent (p·mSv)	170	902	1,072
Average dose equivalent (mSv)	0.9	0.9	0.9

(Period: 1 April 1991 to 31 March 1992)

3. Educational work related to radiation safety

Acting in accordance with security regulations and the Labor Safety and Hygiene Law, the plant held special pre-employment classes on safety for workers who might be employed in radiation-related jobs.

4. Environmental Safety

The plant monitored radiation in the areas surrounding the FUGEN Power Plant and also measured for radioactivity in gas and liquid wastes. It found no unusual problems in any of those findings.

The plant also continued for a second consecutive year to conduct pre-operation inspections on the MONJU prototype fast reactor. It organized the results into a report and submitted that report to the Fukui Prefecture Environmental Radioactivity Monitoring Council.

7) MONJU Fast Breeder Reactor Construction Site

The Monju construction site sought to prevent accidents from occurring by developing a safety control plan that took into account the basic safety control policies formulated at the beginning of 1991. It then implemented specific safety control policies based on that plan.

As a result of those activities, it achieved a perfect record of zero accidents for the year. It also raised employee awareness concerning safety, and provided workers with an assurance of safety in the workplace.

(1) General Safety Management

The Safety and Hygiene Committee met monthly to discuss and study issues related to safety and hygiene.

The site also tried to raise awareness concerning safety in both PNC employees and employees of cooperating companies by holding events during Safety Week, Hygiene Week, and an Electrical Safety Week.

It also formed three safety patrol groups that inspected each area of the site once a week. Each time a discrepancy was found, it took immediate steps to remedy the particular problem.

A council consisting members from both the PNC and cooperating companies was formed to deal with safety control activities in cooperating companies. The council formulated a basic safety and hygiene plan for 1991 for the MONJU construction site, and used the plan to develop a vigorous schedule of activities including regularly scheduled meetings, supervisor meetings, expert subcommittee meetings, and safety patrols.

(2) Monitoring Radiation

1. Monitoring facility radiation

Control zones were established in areas where blanket fuel was being unloaded, and also where the configuration work on the mock reactor core was being done.

As far as monitoring activities within the control zones, the site sought to insure safety by having the Safety Management Department meet beforehand with the department or party supervising the work and go over the radiation work plan. After that, the department gave advice and assistance on radiation protection and made in-person inspections to make sure the work was being performed according to the stated plan.

In 1991, there were 48 cases of work done within control zones.

The site also organized a subcommittee of radiation control experts as a subordinate group working under the Council for Promotion of Safety and Hygiene. The subcommittee did exhaustive work in researching the

specific issues for a radiation education program and in providing general knowledge about radiation safety.

2. Individual exposure control

Acting in accordance with security regulations and provisions pursuant thereto, the site monitored the dose equivalent of workers working in radiation-related jobs. In 1991, the MONJU construction site employed 535 people including a staff of 113 working. All of these employees were involved in configuring a mockup reactor core.

The total yearly dose equivalent was 0.5 person•mSv.

Table 10.6 shows the dose equivalent distribution for employees working at the MONJU construction site. There was no risk of contamination in the control zones, so there was no internal exposure.

3. Educational work related to radiation safety

Acting in accordance with safety regulations and the Labor Safety and Hygiene Law, the site held classes on safety for those employees working in radiation-related jobs.

4. Environmental Safety

The FUGEN Nuclear Power Plant was commissioned to conduct a pre-operation inspection of the MONJU Nuclear Power Plant.

Table 10.6 1991 Exposure Control (MONJU Construction Site)

Item		Employees	Other employees	Total
Effective dose equivalent	(mSv)	113	422	535
Less than 5	(persons)	0	0	0
5~15	(persons)	0	0	0
15~25	(persons)	0	0	0
25~50	(persons)	0	0	0
More than 50	(persons)	113	422	535
Total dose equivalent	(p·mSv)	0.0	0.5	0.5
Average dose equivalent	(mSv)	0.0	0.0	0.0

(Period: 1 April 1991 to 31 March 1992)

10.2 Quality Assurance and Permits

1) Head Office

Below are the basic quality assurance (QA) aims of the PNC head office for 1991.

1. Qualitative improvement of QA activities related to nuclear facilities and order-made products

2. Develop ways to deal with aging of plant and equipment

3. Systematic development of QA educational activities

Working with these goals, the PNC head office provided leadership and support for QA activities implemented in each of these areas for the purpose of insuring safety and improving reliability at nuclear facilities and insuring the quality of order-made products.

A QA committee met in March to discuss and study the basic QA goals and inspection plans for 1992. It also produced a report on QA activities for 1992, PNC inspection results, and specific issues raised during the subcommittee meetings.

The QA Liaison Committee, which links the QA departments in the PNC head office with those in other branch locations, met quarterly to exchange ideas and information on implementing QA activities, basic policy aims, and recommendations arising from PNC inspections.

There was a scheduled PNC inspection in September and October, and a QA diagnosis in March. There were no unusual problems found in either.

Last years, the PNC head office tried to improve the quality of R&D results by organizing a working group to study QA as it pertains to custom-made software products, and by holding QA introductory meetings in May and June on software work at each location in order to try and produce a company-wide report.

During November which was designated as QA Month, it tried to raise awareness concerning QA by presenting company-wide seminars on the subject of improving reliability.

2) PNC Ningyotoge Facility

Below are the QA goals for the PNC Ningyotoge Facility in 1991.

1. Qualitative improvement of QA activities related to facilities and enrichment activities

2. Develop ways to deal with aging of plant and equipment

3. Systematic development of QA educational programs

In order to raise the level of trust and reliability with regard to safety at each of its facilities, the PNC Ningyotoge Facility put together an instruction document and manual that covers most practical daily work activities, and used those materials to increase employee awareness concerning quality assurance.

The QA Promotion Committee met in March to establish the basic QA activities goals for 1992. The QA Promotion Subcommittee, which was established in 1986, met as necessary to research and discuss purchasing controls that can be used throughout the whole company. A QA Supervisory Council, which was set up in 1990, also met to coordinate information exchange activities between each of the facilities.

In the area of regulations, there was a revision of the QA plans for the smelting conversion facility and enrichment engineering facility. Instruction manuals were also prepared for all nine facilities.

From 27 August to 30 November 1991, there was a general in-house inspection of the entire Ningyotoge complex. The inspection was designed to account for the unique characteristics of each facility, but it also covered areas of commonality between each facility, i.e. electric shock prevention systems. As a result of that inspection, there came a flood of requests from each facility. The requests were generally of a positive nature and seemed to be focused on QA.

In November, which was designated as QA Month, QA lectures about QA activities in the reprocessing facility were added to regularly scheduled events, thereby increasing the opportunities for personnel to learn more about QA.

In January 1992, the PNC Ningyotoge Facility started publishing a monthly newsletter that discussed the various QA activities being conducted in each facility. It also produced a QA booklet to help people in each department understand QA fundamentals.

3) PNC Chubu Facility

Below are the basic QA aims for the PNC Chubu Facility. They were based on the PNC QA policies for 1991.

1. Qualitative improvement of QA activities pertaining to the Tono mine
2. Develop ways to deal with aging of plant and equipment
3. Systematic development of QA educational activities
4. Implement in-house inspections

In 1991, the QA Promotion Committee met four times with the goal of keeping attention focused on basic QA policies for 1991 by continuing to produce QA manuals and instruction booklets, and make these into document files or use them as effective daily safety reminders.

In the area of document control pertaining to excavation work in opening the No. 2 mine, a scheduled in-house audit was performed on 19 December, and measures were taken to promote effective QA audits in the interest of firmly establishing QA practices.

QA educational activities, meanwhile, included distribution of QA-related reading material, seminars on improving reliability, educational activities during "QA month", and QA seminars in each department.

In dealing with the aging of plant and equipment, it held a maintenance inspection oriented toward the mine facility and utilities. It also performed inspections to verify aging of equipment, and conducted daily inspections of the mine.

4) PNC Tokai Facility

Below are the QA promotional goals of the PNC Tokai Facility in 1991.

1. Qualitative improvement of QA activities related to nuclear facilities and order-made products

2. Develop ways to deal with aging of plant and equipment

3. Eliminate areas of noncompatibility

4. Improve QA educational activities

The QA activities of the PNC Tokai Facility in 1991 included a review of instructional material and manuals used in each department and plant, QA patrols, solving key issues raised during patrols, developing measures to deal with aging of plant and equipment, promoting preventive safety, thorough safety evaluations of facilities, and instituting more practical educational programs.

The QA Promotion Committee and QA Promotion Subcommittee met four and five times, respectively. The committees formulated a QA activities plan for 1992, studied revisions to the 1991 QA plan, and organized a report entitled Qualification Guidelines for Inspectors, which will be used in facility inspections.

From August 1991 to April 1992, the PNC Chubu Facility conducted a routine in-house inspection to confirm that QA activities were being implemented appropriately in each department and facility.

In November 1991, which was designated as QA Month, it tried to raise general awareness concerning QA by holding events such as quizzes, and by actively getting people to participate in lectures and seminars held on site.

5) Oarai Engineering Center

Below are the basic QA aims for the Oarai Engineering Center in 1991.

1. Improve compatibility of R&D objectives

2. Insure safety and reliability of nuclear facilities

3. Systematic and realistic implementation of QA educational activities

The center implemented QA activities with the aim of improving compatibility of R&D objectives and insuring reliability in the nuclear facilities.

The QA Promotion Committee met in April, October, January, and March, and developed an in-house inspection plan.

In September and March, the nuclear facilities were given an in-house inspection. No particular problems were found. In February, the No. 5 R&D division conducted a self-diagnostic in-house inspection. The results showed no unusual problems.

In November, which was designated as QA Month, the center tried to raise general awareness concerning QA by holding lectures on QA, and by conducting field trips to other companies to see how QA was being implemented at those locations.

In terms of dealing with aging of plant and equipment, the center hosted a conference on the subject of plant and equipment aging.

6) FUGEN Advanced Conversion Reactor Power Plant

Below are the basic QA goals for the FUGEN Advanced Conversion Reactor Power Plant in 1991.

1. Qualitative improvement of QA activities

2. Develop measures to deal with aging of plant and equipment

3. Implement specific measures to eliminate areas of non-compatibility

The QA activities conducted in each department were aimed at maintaining stable operations and improving operational reliability.

The QA Committee met three times during the year to work on the 1991 basic QA goals and in-house inspection plans. A working group on QA also met eight times during the year to formulate an implementation plan for basic QA goals, to make a PNC inspection plan, to study the implementation plan for in-house inspections, and to study which events to hold during QA month.

The regulatory work conducted by the center in 1991 included a review of procedural work involved with revising regulations governing nuclear reactor

facility security, the addition of new control regulations concerning security of the nuclear reactor core facility, and a review of procedures for shutting down plant operations without human error.

An in-house inspection was held in December. The results showed no unusual problems.

The activities held during QA month in November included QA lectures designed to raise QA awareness. In February 1992, the center held lectures on how to prevent human error in order to raise awareness and sensitivity in that particular area. It also sought to educate people about QA by holding a seminars in the Tsuruga area on reliability at which most staff members attended.

7) MONJU Fast Breeder Reactor Construction Site

Below are the 1991 QA goals for the MONJU fast breeder reactor construction site.

1. Promote QA activities oriented toward trial operations
2. Promote MONJU power plant equipment operation
3. Promote streamlined operation and maintenance

In order to conduct comprehensive function tests safely and smoothly, the site made improvement to programs and trial operation procedures. It also established more solid links between the departments and other organizations.

The MONJU QA Committee met every other month to discuss and study issues related to QA activities at the site.

In October, an in-house inspection was given to confirm whether QA activities were being implemented properly, and to verify the effectiveness of those activities.

In November, which was designated as "QA month", activities included a special QA conference for contracting companies, special QA patrols, special QA lectures, and field trips to other PNC locations.

An on-site newsletter entitled QA MONJU was also published in order to get more QA information out.

There was also an inspection of vendors of order-made products to confirm whether QA activities were being performed properly with regard to secondary heat transfers.

8) Permits

Permits and other authorizations were applied for in accordance with a permit application plan for 1991, and according to the laws regulating nuclear source

Table 10.7 1991 Permit Applications

Facility	Application type	PNC Ningyo-toge facility	PNC Chubu facility	PNC Tokai facility	Oarai Engineering Center	FUGEN power plant	MONJU construction site	Total
Nuclear reactor facility	Permits	--	--	--	2	0	0	2
	Construction permits	--	--	--	12	5	3	20
	Inspections	--	--	--	29	7	3	39
	Other applications	--	--	--	3	1	1	5
	Subtotal	--	--	--	46	13	7	66
Reprocessing facility	Permits	--	--	5	--	--	--	5
	Construction permits	--	--	6	--	--	--	6
	Inspections	--	--	27	--	--	--	27
	Other applications	--	--	1	--	--	--	1
	Subtotal	--	--	39	--	--	--	39
Processing facility	Permits	2	--	1	--	--	--	3
	Construction permits	1	--	0	--	--	--	1
	Inspections	4	--	1	--	--	--	5
	Other applications	0	--	0	--	--	--	0
	Subtotal	7	--	2	--	--	--	9
Spent fuel facility	Permits	1	0	6	5	2	2	16
	Inspections	5	0	13	6	0	0	24
	Other applications	1	1	0	0	0	0	2
	Subtotal	7	1	19	11	2	2	42
RI facility	Permits	0	0	1	0	0	0	1
	Inspections	0	0	0	2	0	0	2
	Other applications	0	0	0	0	0	2	2
	Subtotal	0	0	1	2	0	2	5
Total		14	1	61	59	15	11	161

(Period: 1 April 1991 to 31 March 1992)

1) The number of petitions filed by the PNC Tokai Facility and the Oarai Engineering Center with the Mito Nuclear Power Plant regarding RI facilities

2) The number of petitions filed by the power reactor construction and operation headquarters for the nuclear reactor facility at the MONJU construction site

3) The number of petitions filed by the departments responsible for safety excluding the above petitions

materials, fissionable materials, and nuclear reactors. In 1991, the PNC filed for a total of 161 applications with the Science and Technology Agency concerning installation changes, design authorizations, and official inspections. A few specific examples included a request to make changes in the installation of a recycling equipment test facility, a request to make work changes in the construction of a new waste storage warehouse inside the Uranium Enrichment Plant, a request to make changes in a new nitride fuel testing facility and glove box at the 1st plutonium fuel development lab, and a request to make changes in a new glove box being built at the irradiation material test facility.

10.3 Safety Research

1) Promoting a Basic Safety Research Plan

Working from a basic safety research plan, the PNC made an evaluation of safety research results and began a promotion of safety research activities.

(1) Evaluation of Safety Research Results

The previous project, which ran from 1986 to 1990, was completed in 1990, so in 1991, in addition to compiling the usual yearly plan, there was also a five-year plan, so each specific research category had to be analyzed and evaluated in order to compile this five-year plan. The analysis and evaluation of advanced conversion reactors, fast breeder reactors, and nuclear fuel facilities was done by the Safety Research Committee. The analysis and evaluation of probability theories, antiseismic designs, environmental issues, and radioactive waste issues were taken up by various subcommittees organized specifically to deal with those issues. The analysis and evaluations were conducted from the point of view of whether the anticipated results were adequate enough given the previous project's objectives, and also whether the problems were being dealt with in a way that new research material would result. Analysis and evaluation showed that results and progress could be achieved according to plan for the main research topics.

Meetings were also held at which safety research findings related to nuclear fuel facilities and power reactor were announced. This was done so that the research results could be disseminated throughout the company and so an across-the-board analysis and evaluation could be done that went beyond the usual segmented research divisions.

(2) Promotion of a Basic Safety Research Plan

This year was the first year of the basic safety research plan that goes from 1991 to 1995. To get the plan off to a smooth start, it was distributed to every department within the company. The various subcommittees working under the Safety Research Committee also came up with yearly research plans, decided on the best approach to take to promote that research, and tried to develop a methodology for integrating research results. The progress made in the basic research plan was also examined to see whether it started according to plan. A study of inspection results was conducted by the various subcommittees within the Safety Research Committee.

The Safety Research Committee met in February to examine the progress being made, and to discuss future promotional activities in the basic safety research plan and organize the safety research findings over the previous five years.

The promotion of safety research in 1991 went forward according to plan in virtually every single field. There were budgetary and personnel problems in some of the research areas, so some schedule delays occurred. These problem areas were dealt with by providing personnel and budgetary support to those

departments with schedule delays. The basic safety research plan calls for a review when appropriate reason exists to make changes in the external environment. It has decided to take up those issues in 1993.

The various subcommittees conducted studies using WBS techniques in the interest of promoting systematic studies of the basic safety research plan.

2) Implementing Shared Research on Safety

In the area of shared research on the nuclear fuel cycle, the work included evaluations of safety in terms of probability theories, evaluation of emergency events, research on containment functions during failures, research on characteristic safety, and research on criticality safety assurance methods.

(1) Evaluation of Safety in Terms of Probability Theories

With the aim of improving safety of nuclear facilities, verify margins of safety, and appropriately reflect those in design, the PNC developed and collected evaluation techniques, analysis codes, and reliability data, and did PSA evaluation for a model plant. We also made studies and developed evaluation tools for doing comprehensive PSA evaluations of nuclear fuel facilities.

1. **Development of evaluation techniques and analysis codes, and collecting reliability data**

   With the aim of developing evaluation techniques for hazardous operations, accident sequence identification, and more effective methods for studying accident scenarios and how they are caused, the PNC pushing forward with research on a support system which was based on a quantitative risk assessment methods for a chemical plant. This method enables a typical event identification technique such as HAZOP or FMEA to automatically go into operation in an affected facility.

   In 1991, the PNC researched the flow of the support system, created a common input program, and developed a HAZOP support system. It also introduced the use of a dynamic ventilation system evaluation code (RIDO), which is an analysis code used to quantify the probability of an accident occurring and calculate the emission risk of radioactive materials. That code enabled PSA evaluations to be done during the transition stages of an accident.

The PNC continued to collect and collate data for a data base that included equipment operation and maintenance data and reliability data such as failure modes and failure rates which are employed in PSA for nuclear fuel facilities.

In 1991, research was done on how to apply the data being used for PSA in nuclear facilities for nuclear fuel facilities, and find a way to used that data to build a PC-based data base.

2. Applying PSA to a model plant

Using a hypothetical flow sheet for a model plant which has a processing capability three times that of the Tokai reprocessing plant, we quantified the hypothetical probability of an accident occurring in a plutonium evaporator by developing a model PSA system that can be used in plutonium enrichment work.

(2) Research for evaluating emergencies

Even if a temporary abnormal condition exists in a nuclear fuel facility, the event transition is generally peaceful, so it is very hard to envision the accident spreading. A study was done on ways to prevent the occurrence and spread of an accident and minimize its effect from the perspective of assuring safety in the hypothetical situation of a temporary accident. The object of the study was to assume that a disaster or explosion had taken place in a hypothetical situation and to assume that a relatively large amount of energy was released and that the containment system has been affected. Under that scenario, the study examined the mechanism by which the event occurred, developed a model for continuous change, and ascertained aerosol behavior. This not only helped contribute to perfecting a safety assessment method, i.e. PSA, but also proved very useful in improving safety, establishing appropriate margins of safety, establishing guidelines, and setting standards for the facility.

1. Research on elucidating the decomposition mechanism of decomposable compounds within a work process

This research assumed that an accident caused by an organic solvent fire had started at a reprocessing facility and there had been a decomposition of compounds. The research included a study of possible scenarios that might have caused the accident, a study of measures that could have been taken to prevent the accident, and a study of the thermal and chemical characteristics of the compounds.

2. Research on safety assessment items involving large-scale cells

This research involved elucidating the safety assessment items needed for assuring safety in the hypothetical situation of a fire, and using an engineering experiment to elucidate the items needed for confirmation. The research also looked into the applicability of existing evaluation codes and test concepts in view of a hypothetical accident involving a large-scale cell (remote).

3. **Research on PSA methods**

Work was done on the FIRIN code for evaluating the behavior of aerosol during hypothetical conflagration. A study was also done on test items and test methods for ascertaining aerosol emission behavior.

(3) Research on containment function during emergency

With the object being to establish proper margins of safety, guidelines, and standards, and use those to perfect safety assessment methods such as PSA, this research on containment technology, which can be used in all nuclear fuel facilities, included a study to determine the soundness of containment elements, i.e iodine filters (also includes cells), and ways to ascertain the behavior of aerosols within thermal air currents in ventilation systems during a fire.

1. **Testing aerosol behavior during an emergency**

A test device was designed to help understand the behavior of aerosols inside thermal air currents during a fire. A test box was installed to help with behavioral research on fires inside the glove box (research done with help of plutonium fuel plant). Basic data such as combustion speed and radiant heat was collected on various combustion materials tested. The aerosols inside the glove box underwent a combustion test to obtain data on negative pressure fluctuations. An implementation plan was devised to gain a better understanding of the behavior of smoke inside a cell during a fire.

2. **Testing ventilation system elements during an emergency**

These were a series of tests to show how ventilation systems such as HEP filters and iodine filters hold up under emergency situations. This was followed by a study on test items and test methods needed for verifying the soundness of those filters.

3. **Developing containment-related codes**

The ventilation system aerosol behavior analysis code FIRAC was introduced as a containment-related evaluation code. The FIRAC code was verified using results from research on the behavior of fire inside a glove box.

(4) Research on Characteristic Safety in Nuclear Fuel Facilities

The radiolytic hydrogen and decay heat which are produced at high-level liquid waste storage facilities inside the reprocessing plant were eliminated through the use of a dynamic scavenge air and coolant circulation system. To assure high reliability of the system, the power supply and equipment were multiplexed. Feasibility studies were done on a static heat removal system and a static hydrogen removal system for a high-level liquid waste storage center where the focus was on characteristic safety for the purpose of achieving high

reliability with regard to assuring safety during an emergency and making it more economical. The following research was conducted with the aim of conducting applied research in that area.

1. **Research on static hydrogen removal system for high-level liquid waste storage tank**

   A conceptual study was done on a static hydrogen removal system for use in a high-level waste tank not powered by an auxiliary system. A conceptual study was also done on a test device that would test the characteristics of oxygen-hydrogen rebonding catalysts as an extractant.

2. **Study of static heat removal system**

   A conceptual study was done on a static heat removal system for use in high-level liquid waste storage tank (cooling system that uses separated heat pipes).

(5) Research on Criticality Safety

One of the serious problems confronting the practical implementation of nuclear fuel cycle facilities is improving reliability and accuracy with regard to analyzing criticality safety, and trying to rationalize the design. That led to the following research which was conducted with the aim of perfecting practical methods for analyzing criticality safety and control for the purpose of increasing the quantity of plutonium being handled and producing higher grade plutonium isotopes.

1. **Development of criticality safety analysis codes and library**

   A new version (MCNP4) of the continuous energy Monte Carlo code that employs a nuclear point data library (MCNP) was introduced. The applicability of MCNP4 to analyzing criticality safety in plutonium fuel handling was verified by calculations that employ critical experiment data related to plutonium fuel handling facilities. An evaluation of the burnup credit was initiated for the purpose of coming up with a rational criticality safety design.

2. **Criticality safety guidebook**

   Work was started on a criticality safety guidebook that would reflect the knowhow and capability of PNC nuclear fuel facilities. The SCALE4 code from last year was used to calculate criticality safety data for the plutonium fuel processing facility.

3) Establishing Safety Standards

The PNC took part in survey committee meetings commissioned by the government and presented information and materials on structural and welding standards for reprocessing facilities, on upgrading pre-inspection uses, and on handling new materials and new technologies. It also helped review technology standards and make proposals regarding inspections.

The PNC also took part in survey committee meetings commissioned by the government to conduct research on standardizing on-site test methods for

high-performance air filters used in radiation aerosols, on JIS revisions to the air filters system, and on reducing the amount of spent aerosol being treated. At these meetings, it submitted revised drafts, cooperated in discussions, and helped with on-site surveys.

A study was begun within the PNC on creating a standard glove box design.

4) Other Activities

In April 1992, the PNC helped organize lectures and arrange meetings at the International Atomic Energy Safety Forum put on by the Nuclear Safety Commission. In October 1991, it also participated in a conference of experts on nuclear fuel facility safety put on by the OECD/NEA and CSNI. Here, it helped announce research results and manage the meetings. The PNC also did revisionary work on a draft of a nuclear fuel cycle safety report by the OECD/NEA and CSN, and took part in, and helped manage, a conference on the subject in October.

With respect to international nuclear evaluation standards (INES) of the IAEA, the PNC wrote a commentary on the subject, and participated in the technology committee meeting thereof in March 1992 and helped formulate a manual for using said standards.

The PNC also issued a report on what it is doing as part of an IAEA survey asking various countries to report on what they are doing regarding "human factor."

PNC Organizational Chart

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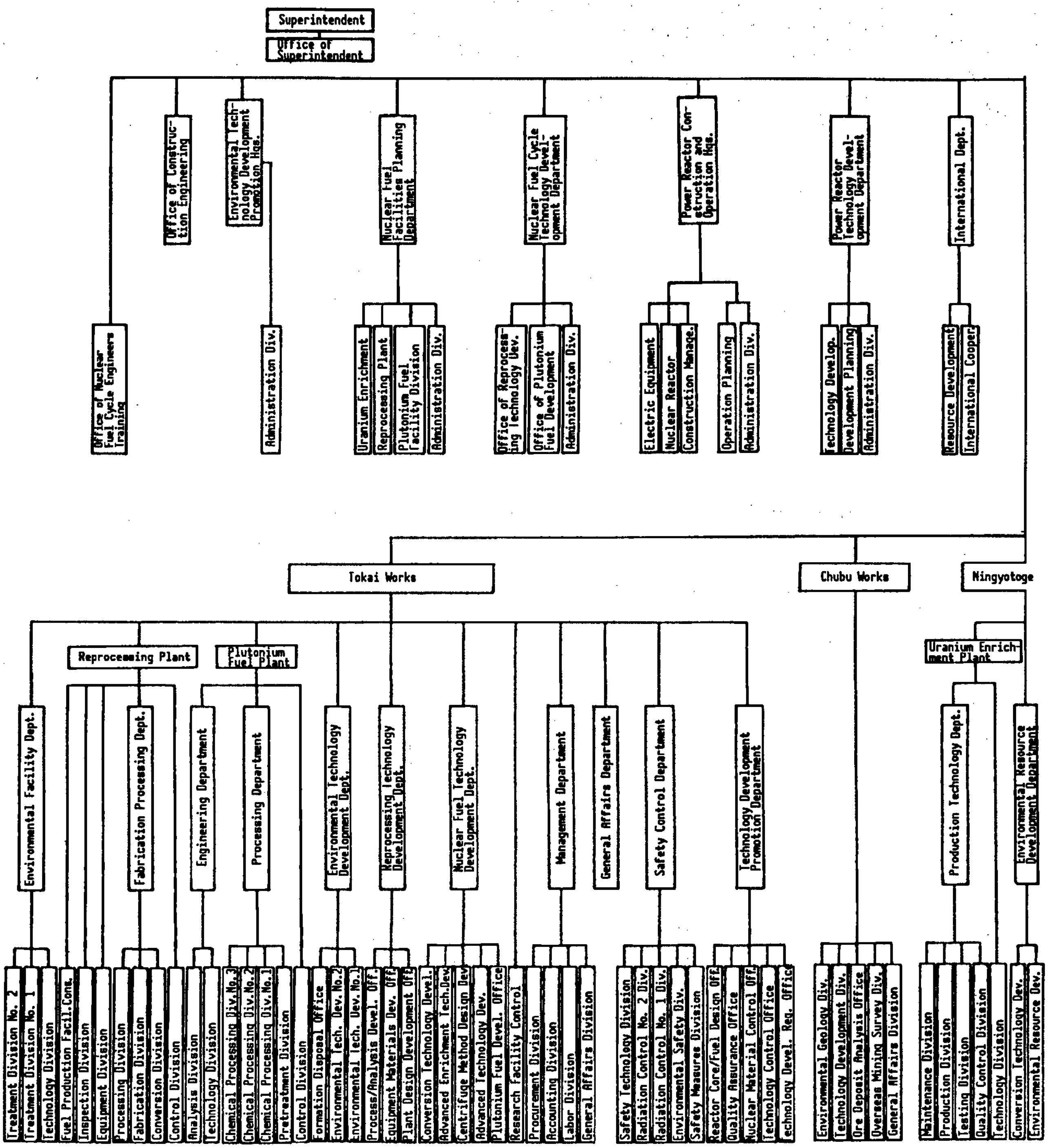

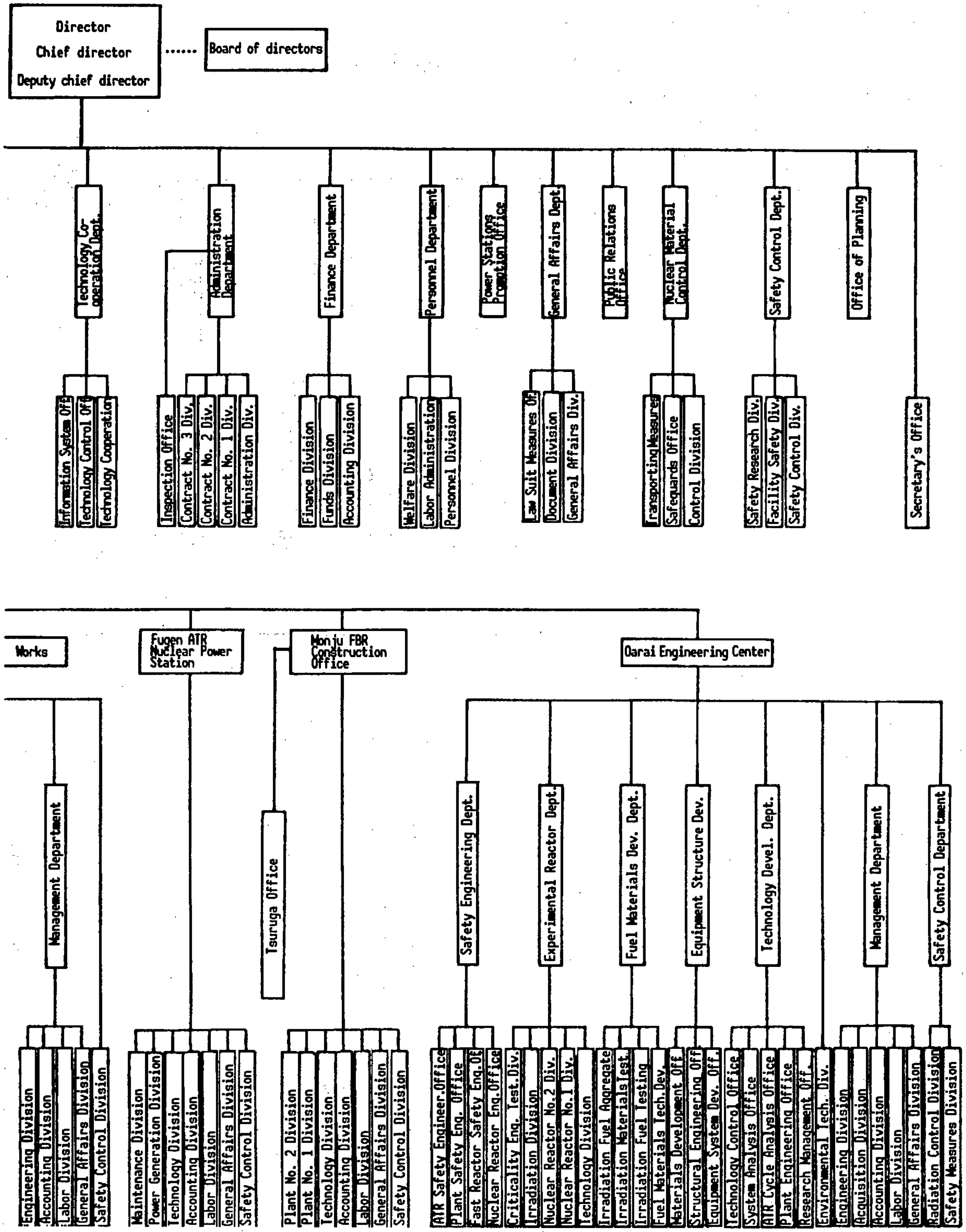
Director
Chief director
Deputy chief director
Board of directors
Technology Co-operation Dept.
Administration Department
Finance Department
Personnel Department
Power Stations Promotion Office
General Affairs Dept.
Public Relations Office
Nuclear Material Control Dept.
Safety Control Dept.
Office of Planning
Information System Off.
Technology Control Off.
Technology Cooperation
Inspection Office
Contract No. 3 Div.
Contract No. 2 Div.
Contract No. 1 Div.
Administration Div.
Finance Division
Funds Division
Accounting Division
Welfare Division
Labor Administration
Personnel Division
Law Suit Measures Off.
Document Division
General Affairs Div.
Transporting Measures
Safeguards Office
Control Division
Safety Research Div.
Facility Safety Div.
Safety Control Div.
Secretary's Office
Works
Fugen ATR Nuclear Power Station
Monju FBR Construction Office
Oarai Engineering Center
Management Department
Tsuruga Office
Safety Engineering Dept.
Experimental Reactor Dept.
Fuel Materials Dev. Dept.
Equipment Structure Dev.
Technology Devel. Dept.
Management Department
Safety Control Department
Engineering Division
Accounting Division
Labor Division
General Affairs Division
Safety Control Division
Maintenance Division
Power Generation Division
Technology Division
Accounting Division
Labor Division
General Affairs Division
Safety Control Division
Plant No. 2 Division
Plant No. 1 Division
Technology Division
Accounting Division
Labor Division
General Affairs Division
Safety Control Division
ATR Safety Engineer. Office
Plant Safety Eng. Office
Fast Reactor Safety Eng. Off.
Nuclear Reactor Eng. Office
Criticality Eng. Test. Div.
Irradiation Division
Nuclear Reactor No. 2 Div.
Nuclear Reactor No. 1 Div.
Technology Division
Irradiation Fuel Aggregate
Irradiation Materials Test.
Irradiation Fuel Testing
Fuel Materials Tech. Dev.
Materials Development Off.
Structural Engineering Off.
Equipment System Dev. Off.
Technology Control Office
System Analysis Office
ATR Cycle Analysis Office
Plant Engineering Office
Research Management Off.
Environmental Tech. Div.
Engineering Division
Acquisition Division
Accounting Division
Labor Division
General Affairs Division
Radiation Control Division
Safety Measures Division

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